



Atty. Docket No. 002935 USA/PDC/ICT/OR
PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of

Dieter WINKLER et al.

Application No.: 09/162,103

Group Art Unit: 2881

Confirmation No.: 8426

Examiner: B. Anderson

Filed: September 28, 1998

For: CHARGED PARTICLE BEAM MICROSCOPE WITH MINICOLUMN

SUBMISSION OF APPELLANT'S BRIEF ON APPEAL

Commissioner for Patents
Washington, D.C. 20231

Sir:

Further to the Notice of Appeal filed December 12, 2001, submitted herewith please find an original and two copies of Appellant's Brief on Appeal. A check for the statutory fee of \$320.00 is attached. Authorization is also given to charge or credit any difference or overpayment to Deposit Account No. 19-4880. A duplicate copy of this paper is attached.

Respectfully submitted,

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Date: February 12, 2002

Signed: *Thea K. Wagner*
Thea K. Wagner



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APPELLANT'S BRIEF ON APPEAL UNDER 37 C.F.R. § 1.192

Commissioner for Patents
Washington, D.C. 20231

Sir:

Appellants, within a two (2) month period from the December 12, 2001, filing date of the Notice of Appeal, herein file an Appeal Brief drafted in accordance with the provisions of 37 C.F.R. § 1.192, as follows:

I. REAL PARTY IN INTEREST

The real party in interest is the owner of the application, APPLIED MATERIALS, INC.

II. RELATED APPEALS AND INTERFERENCES

To the best of their knowledge, Appellants are not aware of any other appeals or interferences involving the present application.

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III. STATUS OF CLAIMS

Claims 1-26 are all the claims pending in the subject application. Claims 1, 4 and 7-11 stand rejected under 35 U.S.C. § 102(b) as being anticipated by or, in the alternative, under 35 U.S.C. § 103(a) as being unpatentable over Sturrock et al., USP 5,786,601 ("Sturrock"). Claims 2-3 and 5-6 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Sturrock, in view of Schamber, et al., USP 5,376,792 ("Schamber"). Claims 12-26 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Sturrock.

IV. STATUS OF AMENDMENTS

The claims have not been amended pursuant to final rejection.

V. SUMMARY OF THE INVENTION

Conventional electron microscopes used for the inspection and manufacture of integrated circuits comprise an electron beam column and a chamber containing a wafer. Both the microscope and the chamber are interconnected, so that there is at least a relationship between respective levels of vacuum. In addition, a separate vacuum system has been provided for each of the column and its associated chamber, as discussed on pages 1 and 2 of the specification with reference to Figure 1.

In such systems, the vacuum must be released in the course of inspection and maintenance, resulting in exposure of both the column and the chamber to atmospheric pressure. After the inspection or maintenance cycle is complete, it is necessary to pump down both the column and the chamber again. The pumpdown process is time-consuming, and can result in several hours of downtime after each maintenance cycle.

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As described on pages 2 and 3 of the specification with reference to Figure 2, minicolumns, having a height that is a fraction of the height of a conventional column (less than ten centimeters, or less than four inches, compared with 15-30 inches for a conventional column) have been developed.

The present invention is directed to an electron microscope having one or more "minicolumns" in which the minicolumn(s) is/are located within an inspection chamber, either housed in a separate mini-environment insertable into the inspection chamber, or in the inspection chamber itself. This separate environment significantly reduces the volume of vacuum that must be released when a minicolumn requires maintenance, thereby reducing the time necessary to re-establish the necessary vacuum.

The placement of a minicolumn in its own minienvironment, or in the chamber itself, means that separate vacuum systems for the column and the chamber no longer are necessary. It also means that the minicolumn can be inserted into a chamber via a load lock, for example, without requiring breaking the vacuum of the chamber.

The small size of the minicolumn relative to the chamber also permits the insertion of multiple minicolumns into the chamber, for example, on an arm, as shown in Figures 7A and 7B. More minicolumns per chamber means faster operation, and hence increased throughput. In addition, as shown for example in Figures 3A and 3B of the application, a bellows structure may be provided for introducing one or a plurality of minicolumns into, and removing one or a plurality of minicolumns from a main vacuum chamber. Still further, the small size of minicolumns facilitates

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their provision in a chamber such that one or more of the minicolumns may be tilted, as illustrated in exemplary fashion in Figure 5B.

Having all of this structure located within a chamber also permits the use of a turntable stage for a substrate or other article, rather than an X-Y stage, meaning that the overall structure is much smaller. Moreover, smaller size of the minicolumns means that multiple minicolumns can be provided, including placement on an arm. Throughput can be enhanced substantially as a result.

VI. ISSUES

1. Does the prior art teach or reasonably suggest an electron microscope having a separate mini-environment for a mini-column as recited in claims 1, 2, 4-6, 18, and 19?
2. Does the prior art teach or reasonably suggest an electron microscope having a bellows structure for introducing one or a plurality of minicolumns into and extracting one or a plurality of minicolumns out of a chamber, as recited in claims 3 and 20?
3. Does the prior art teach or reasonably suggest an electron microscope having a mini-column located within a vacuum chamber as recited in claims 7-8 and 11?
4. Does the prior art teach or reasonably suggest an electron microscope having a turntable stage as recited in claims 12-15, and 24?
5. Does the prior art teach or reasonably suggest an electron microscope with a plurality of minicolumns as recited in claim 21?
6. Does the prior art teach or reasonably suggest an electron microscope having minicolumns that are tilted or tiltable as recited in claims 9-10, 16-17, 22-23, and 25-26?

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VII. GROUPING OF CLAIMS

Claims 1, 2, 4-6, 18, and 19 stand and fall together. Claims 3 and 20 stand and fall together. Claims 7-8 and 11 stand and fall together. Claims 12-15, and 24 stand and fall together. Claim 21 stands and falls on its own. Claims 9-10, 16-17, 22-23, and 25-26 and fall together.

VIII. ARGUMENTS

Issue 1: Does the prior art teach or reasonably suggest an electron microscope having a separate mini-environment for a mini-column as recited in claims 1, 2, 4-6, 18, and 19?

Claims 1, 2, 4-6, 18, and 19 recite an electron microscope in which the electron beam column is located in a chamber separate from but connectable to (or insertable in) an inspection chamber. These claims go on to recite a mini-environment housing either a minicolumn, or a plurality of minicolumns. The Examiner relies upon Sturrock, either alone or in combination with Schamber, to reject these claims. However, Sturrock and Schamber do not anticipate, teach or suggest, alone or in combination, even a minicolumn, much less a minienvironment housing one or a plurality of minicolumns. To the contrary, Sturrock describes only a conventional electron beam column that is attached to an inspection chamber using a means to ensure that the electron beam remains in a fixed relation to a wafer, thereby overcoming misalignment due to distortion caused by thermal transients, weight or changes in vacuum. Further, neither Sturrock nor Schamber teaches or suggests placing an electron beam column in a separate environment.

The Examiner directs Appellants' attention to Sturrock, col. 2, lines 23-37 as allegedly teaching a minicolumn enclosed in a vacuum mini-environment:

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According to the present invention there is provided an electron beam lithography machine comprising a movable support for a substrate, an electron beam column for providing an electron beam to scan the substrate, a contactless position monitoring system for monitoring the position of the substrate relative to the optical axis of the column, and a rigid mounting body mounting the support means and the column, characterised in that components of the monitoring system are mounted in mutually fixed relationship on a rigid carriage which is supported relative to the body at a plurality of contact points provided by rollable members, the rollable members being arranged to secure the carriage against tilt relative to the body and to permit limited deformation of the body substantially without influence on the position of the components relative to the axis.

Appellants find no reference to a minicolumn or to a separate environment for an electron beam column, much less a separate minienvironment for a minicolumn, much less a minienvironment for a plurality of minicolumns. Instead, all the figures and references in Sturrock relate to a conventional electron beam column, not a minicolumn or anything implying size for a minicolumn such as described in the present application. *See, e.g.,* Sturrock, col. 4, lines 2-4, "[t]he machine incorporates an electron beam optical column 11, of which only the lower end portion is shown in FIG. 1. ...", col. 4, lines 12-14, "[t]he column 11 is mounted on a unitary steel plate 12, which is of relatively massive construction to optimize rigidity," col. 6, lines 16-18. "... due to change in ambient temperature or heat conduction or radiation from components within the electron beam column 11." (*Emphasis added.*) All of these statements relate to a conventional electron beam column, and not in any way to a minicolumn.

Second, Sturrock does not disclose or suggest a separate environment for the electron beam column. The failure of Sturrock to teach a sufficiently small column militates against such an interpretation of Sturrock, and Schamber does nothing to remedy that deficiency.

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The Examiner has asserted that the prior art disclosed an electron beam column and that the difference between the prior art and the current application was one merely of size, and therefore that the rejected claims would have been obvious in view of the prior art. Appellants have rebutted the Examiner's argument by arguing that the current invention differs from the prior art by features of an electron microscope made possible by the size of a minicolumn. These features are recited in the independent claims. *See*, Appellants' Response, September 27, 2001. Appellants are not relying on the size differences between a conventional electron beam column and a minicolumn, but upon the features that are now possible because of the extremely small size of the minicolumn. The features which are made possible by minicolumn size are not taught or suggested by the prior art of record. Therefore, there is no motivation in the prior art to provide the configurations set forth in claims 1, 2, 4-6, 18, and 19, and therefore Appellants submit that these claims are patentable.

Issue 2: Does the prior art teach or reasonably suggest an electron microscope having a bellows structure for introducing one or a plurality of minicolumns into and extracting one or a plurality of minicolumns out of a chamber, as recited in claims 3 and 20?

Further, as recited in claims 3 and 20, the present invention describes a bellow structure for inserting minicolumns into an inspection chamber and extracting minicolumns from an inspection chamber. There is no teaching or suggestion in Sturrock or Schamber, nor in any reasonable combination thereof, that an electron beam column may be inserted into or extracted from an inspection chamber, and certainly not in this fashion. Sturrock is directed to an electron beam lithography machine having a means for adjusting the position of a wafer to compensate for any relative movement between an electron beam column and an inspection chamber.

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Sturrock recognizes that movement may exist through deformation or thermal expansion that affects the placement of the electron beam. Rather than move either the electron beam column or the inspection chamber in relation to the other, Sturrock moves the wafer. *See*, Sturrock, col. 4, lines 55-59, "[i]n order to accurately monitor the position of the stage thereby to allow its movement to be controlled with the degree of precision required, the machine is equipped with an optoelectronic position monitoring system operating on the basis of laser interferometry." Clearly Sturrock teaches away from effecting relative movement between an electron beam column and an inspection chamber.

For at least this additional reason, dependent claims 3 and 20 are patentable as well.

Issue 3: Does the prior art teach or reasonably suggest an electron microscope having a mini-column located within a vacuum chamber as recited in claims 7-8 and 11?

Claims 7-8 and 11 recite a minicolumn placed inside an inspection chamber. Neither Sturrock nor Schamber teaches or suggests that an electron beam column may be placed inside an inspection chamber. Schamber is silent regarding an inspection chamber. Sturrock mounts the electron beam column on the inspection chamber, not within the inspection chamber. *See* Sturrock, col. 4, line 12, "[t]he column 11 is mounted on a unitary steel plate 12 ...", col. 4, lines 37-42, "[t]he plate 12 and the depending carrier together form a rigid body mounting the beam column and substrate support. This mounting body is enclosed, ... , by a vacuum vessel consisting of a lid 19 and a casing 20 ...". Sturrock's electron beam column is mounted to, not contained within, an inspection chamber.

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Because a minicolumn is considerably smaller than a conventional electron beam column, the minicolumn may be placed entirely within an inspection chamber, thereby obviating the need for a higher capacity vacuum pump, or alternatively, a separate vacuum pump for the electron beam column. Again, none of the prior art teaches or suggests that an electron beam column be mounted within an inspection chamber. For at least this reason, claims 7-8 and 11 are patentable.

Issue 4: Does the prior art teach or reasonably suggest an electron microscope having a turntable stage as recited in claims 12-15, and 24?

The Examiner has asserted that a turntable stage is the equivalent of an x-y stage, and therefore that the provision of a turntable stage would have been obvious in view of Sturrock. An x-y stage allows a wafer to be moved in an x direction, a y direction, or a combination of both an x and a y direction. In contrast, a turntable stage rotates the wafer through 360 degrees about its vertical axis. Appellants have previously advanced two arguments that refute the Examiner's assertion that "the x-y stage and turntable stage are considered art-recognized equivalents...." See Office Action, January 12, 2001, para. 12. At least one purpose of Sturrock's stage is to secure the wafer and to position it beneath a fixed electron beam.¹ Applicant's first argument is that an x-y stage requires an area that is several four times the area of a wafer, in order to locate any position of the wafer beneath the electron beam. As a result,

¹ Sturrock's electron beam may be steerable such that the beam may be electronically deflected to various locations on the wafer near the electron beam axis. However, this deflection is not sufficient to reach all locations on the wafer, therefore wafer movement is accomplished by an x-y stage so that all wafer locations may be positioned directly beneath the electron beam.

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the necessary volume of the inspection chamber would be increased considerably, beyond that required by just the stage itself.

By contrast, as recited in claims 12-15 and 24, a turntable stage in combination with one or a plurality of minicolumns mounted on a holding arm may position a minicolumn over any location of the wafer, requiring a much smaller chamber, much more comparable in size to only the surface area of the stage. Clearly the use of a turntable stage minimizes the area, and thus the volume, of the inspection chamber. For at least this reason, a turntable stage is not the equivalent of an x-y stage.

Appellants' second argument relates to using a turntable stage in combination with a conventional electron beam column. Because a conventional electron beam column is fixed in relation to the inspection chamber, it is focused only on a single location of the wafer. For the electron beam to be focused on every location of the wafer, the wafer must be moved in relation to the electron beam in either one of the x and y directions. A turntable stage only rotates a wafer around its axis. Therefore, a fixed electron beam will only describe a circumference of a circle² as the stage rotates, and cannot illuminate each and every location of the wafer. It may illuminate only those locations of the wafer located on the circumference of the circle. Therefore, a turntable stage may not be used with a conventional electron beam column if the entire wafer is to be inspected. For this reason as well, a turntable stage is not the equivalent of an x-y stage.

² The diameter of the circle is twice the offset distance of the axis of the rotatable stage and the axis of the electron beam.

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The present invention as described in claims 12-15, and 24 has a minicolumn mounted on a pivot arm to provide relative movement between the wafer and the electron beam thereby, in combination with the rotation of the wafer, providing the capability to illuminate each and every location of the wafer. A conventional electron beam column is fixed and is not moveable in relation to the axis of rotation of a turntable stage. A minicolumn, because of its size/weight in comparison to a conventional electron beam column, may be mounted on a pivot arm within an inspection chamber.

Neither Sturrock nor Schamber, nor any reasonable combination thereof, teaches or reasonably suggests a minicolumn. Moreover, these references teach away from using a turntable stage with a conventional electron beam column. Because Sturrock and Schamber teach away from using a turntable stage, claims 12-15 and 24 would not have been obvious in view of Sturrock and Schamber, and therefore are patentable.

Issue 5 Does the prior art teach or reasonably suggest an electron microscope with a plurality of minicolumns as recited in claim 21?

The Examiner has posited that providing more than one minicolumn in a Sturrock/Schamber combination is a mere duplication of parts. However, there is simply nothing in Sturrock, Schamber, or any reasonable combination thereof, that suggests that, even assuming *arguendo* that such duplication was desirable, such duplication was achievable in any reasonable combination of the two references. Size alone, as shown in those references, dictates otherwise.

The prior art on which the Examiner relies, showing only a single column, and not even a minicolumn, cannot possibly teach or reasonably suggest the improvements in throughput that result from having a plurality of minicolumns in an electron microscope. Different or multiple

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views of a single objective, or single views of multiple objectives, are possible with the claimed arrangement. None of these possibilities is suggested, or even achievable with the prior art of record, no matter how that prior art is combined.

Pursuant to the foregoing, Appellants submit that claim 21 is patentable over Sturrock and Schamber, or any combination thereof.

Issue 6 Does the prior art teach or reasonably suggest an electron microscope having mini-columns that are tilted or tiltable as recited in claims 9-10, 16-17, 22-23, and 25-26?

A *prima facie* case of obviousness must include some suggestion or motivation to modify and/or combine the teachings of the prior art references, a reasonable expectation of success, and a teaching or suggestion of all of the claim limitations. However, in the present case, neither Sturrock nor Schamber teaches or even remotely suggests tilting an electron beam.

Claims 9-10, 16-17, 22-23, and 25-26 recite an electron microscope having one or more minicolumns that are tilted with respect to the wafer under inspection. The Examiner relies upon Sturrock, col. 2, lines 38-63 to describe a tilting means for the electron beam column, thereby concluding that claims 9-10, 16-17, 22-23, and 25-26 would have been obvious in view of Sturrock. Appellants disagree with the Examiner's reference that Sturrock teaches or reasonably suggests tilting of an electron beam column. To the contrary, Sturrock teaches away from tilting an electron beam column. Sturrock is directed to an electron lithography machine having a means for achieving greater stability of the positional relationship of the components to each other and to the beam axis.

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See, Sturrock, col. 2, lines 17-20. Sturrock specifically teaches against a tilt of the beam axis with respect to the wafer. *See*, col. 5, lines 8-9 “[a]n optimum security of the carriage against tilt relative to the body...”; col 5, 53-55 “[t]his number and disposition of the support locations ensures that the carriage can bear against the place 12 completely free of any possibility of tilt or rocking.” (*Emphasis added.*)

Because Sturrock teaches away from tilting an electron beam, Sturrock cannot possibly teach or suggest this feature of claims 9-10, 16-17, 22-23, and 25-26. Schamber, relating to a replaceable liner for an electron beam column, is silent on tilting the electron beam relative to the wafer, and thus does not supply the deficiencies of Sturrock in this regard. Therefore, Appellants submit that claims 9-10, 16-17, 22-23, and 25-26 are patentable for this additional reason as well.

IX. CONCLUSION

Pursuant to the foregoing arguments, Appellants submit that claims 1-26 in the subject application are patentable. Accordingly, Appellants respectfully request that the Examiner's rejections be reversed, and the application allowed at the earliest opportunity.

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The present Brief on Appeal is being filed in triplicate. Appellant hereby petitions for any extension of time which may be required to maintain the pendency of this case, and any required fee for such extension is to be charged to Deposit Account No. 19-4880.

Respectfully submitted,

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Signed: Thea K. Wagner
Thea K. Wagner

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APPENDIX

CLAIMS 1-26 ON APPEAL:

1. An electron microscope, comprising:

a main vacuum chamber housing a stage therein and connected to a vacuum pump;

a load lock for loading specimen into said main vacuum chamber;

a minicolumn; and,

a mini -environment housing said minicolumn.
2. The electron microscope of claim 1, wherein said mini-environment comprises an opening to the main chamber for introducing said minicolumn into the main vacuum chamber and extracting said minicolumn from said main vacuum chamber.
3. The electron microscope of claim 1, wherein said mini-environment comprises a bellows structure for introducing said minicolumn into the main vacuum chamber and extracting said minicolumn from said main vacuum chamber.
4. The electron microscope of claim 1, wherein said mini-environment comprises an evacuation outlet.

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5. The electron microscope of claim 1, wherein said mini-environment comprises a second chamber having an opening into said main chamber, and a valve structure for hermetically sealing said opening.
6. The electron microscope of claim 5, wherein said valve comprises a sealing plate anchored to a pivot and movable in the Z-direction.
7. An electron microscope, comprising:
 - a main vacuum chamber housing a stage therein and connected to a vacuum pump;
 - a load lock for loading a specimen into said main chamber; and,
 - a minicolumn positioned inside said main chamber.
8. The electron microscope of claim 7, further comprising a back plate attached to said main chamber, and wherein said minicolumn is connected to the back plate.
9. The electron microscope of claim 7, further comprising at least one tilted minicolumn situated inside said main vacuum chamber at a tilt with respect to the minicolumn.
10. The electron microscope of claim 9, wherein said tilt is variable.

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11. The electron microscope of claim 7, further comprising a vacuum pump situated inside the main vacuum chamber and connected to the minicolumn.
12. An electron microscope, comprising:
 - a main vacuum chamber connected to a vacuum pump and housing:
 - a turntable stage;
 - a holding arm; and,
 - a minicolumn attached to said holding arm.
13. The electron microscope of claim 12, further comprising a radial pivot, and wherein said arm is connected to said radial pivot.
14. The electron microscope of claim 12, further comprising a linear motion carriage, and wherein said arm is connected to said linear motion carriage.
15. The electron microscope of claim 12, further comprising at least one additional minicolumn connected to said holding arm.
16. The electron microscope of claim 15, wherein said at least one additional minicolumn has a tilt with respect to the minicolumn.

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17. The electron microscope of claim 16, wherein the tilt is variable.
18. An electron microscope, comprising:
 - a main vacuum chamber housing a stage therein and connected to a vacuum pump;
 - a load lock for loading a specimen into said main vacuum chamber;
 - a plurality of minicolumns; and
 - a mini-environment housing said minicolumns.
19. The electron microscope of claim 18, wherein said mini-environment comprises an opening to the main chamber for introducing said minicolumns into the main vacuum chamber and extracting said minicolumns from said main vacuum chamber.
20. The electron microscope of claim 18, wherein said mini-environment comprises a bellows structure for introducing said minicolumns into the main vacuum chamber and extracting said minicolumns from said main vacuum chamber.
21. An electron microscope comprising:
 - a main vacuum chamber housing a stage therein and connected to a vacuum pump;
 - a load lock for loading a specimen into said main vacuum chamber; and
 - a plurality of minicolumns.
22. The electron microscope of claim 21, wherein at least one of said minicolumns is situated inside the main vacuum chamber at a tilt with respect to the other minicolumns.

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23. The electron microscope of claim 22, wherein said tilt is variable.
24. An electron microscope comprising:
 - a main vacuum chamber connected to a vacuum pump and housing:
 - a turntable stage;
 - a holding arm; and
 - a plurality of minicolumns attached to said holding arm.
25. The electron microscope of claim 24, wherein at least one of said minicolumns has a tilt with respect to the other minicolumns.
26. The electron microscope of claim 25, wherein said tilt is variable.